

FT-IR Studies of Femto-second Laser Ablated CARC Coatings

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Introduction: Paint/re-paint operations cost the army approx. \$150 million dollars annually. These operations, as applied to CARC (Chemical Attack Resistant Coatings), release VOCs (Volatile Organic Compounds) into the environment and therefore present an environmental as well as financial burden. By precisely identifying the failure mechanisms involved, it may be possible to reduce the frequency of paint / re-paint operations.

Methods and Materials: Fourier Transform Infrared Spectroscopy (FT-IR) is the fundamental technique being used to identify chemical changes linked to CARC failure in this study. Specifically, this technique is being used in conjunction with femto-second laser ablation to reveal chemical changes at multiple depths within the coating. The unique nature of the femto-second ablation process allows varying amounts of material to be removed with virtually no thermo-chemical damage. These ablated windows were subjected to FT-IR analysis via diamond crystal micro-ATR analysis in an effort to identify changes caused both by weathering processes as well as femto-second ablation artifacts. Depths of these ablated windows were determined via scanning confocal profilometry and related to the penetration depths of incident UV energy used to simulate weathering conditions.

Results: Micro-ATR spectra were collected on both non-ablated as well as ablated regions of CARC coating in an attempt to identify whether the ablation process itself caused any chemical changes to the sample. These spectra are shown in **Figure 1**. No chemical changes as a result of the ablation process are visible. This preliminary data is a strong indication that femto-second laser ablation can be safely used to remove thin layers of a sample while at the same time preserving the sample's original chemical nature.

It was found that contact pressure between the diamond micro-ATR crystal and the sample surface caused dramatic changes in the amount and nature of characteristic peaks within the spectra. This could be due to peaks becoming clearly visible under greater pressure as the rough sample surface flattens out and fills voids underneath the crystal face. It could also be indicative of subsurface material coming into contact with the crystal face as the crystal is introduced further and further into the sample. Because of this pressure dependant effect, spectra were collected at light, moderate and heavy pressures in order to collect data under all possible conditions. **Figure 2** shows the differences present in spectra collected from the same sample position under both light and heavy contact pressure.

Conclusions: Femto-second laser ablation causes no obvious changes to the chemical nature of the sample and is an effective method for removing thin layers from the sample surface. ATR crystal pressure must be selected carefully in order to collect spectra indicative of the true chemical nature of the sample surface.

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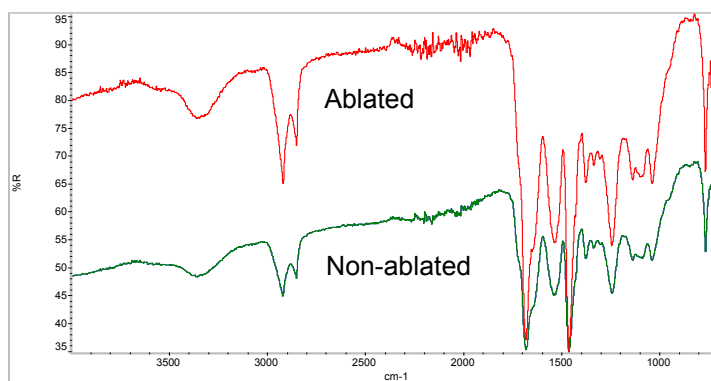


Figure 1. Ablated vs. Non-Ablated infrared spectra of CARC coating showing no thermo-chemical damage as a result of femto-second laser ablation process.

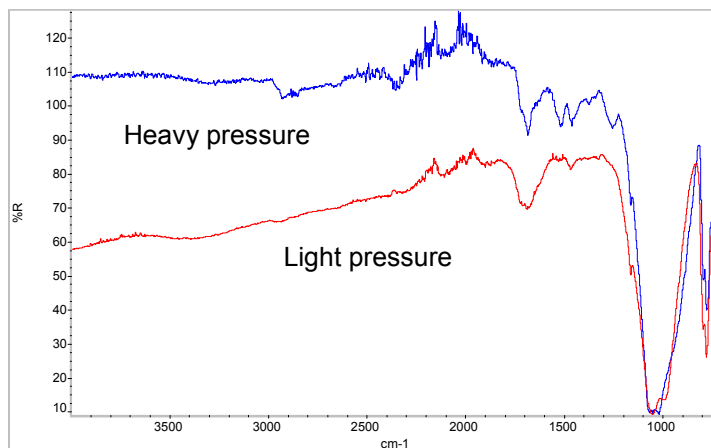


Figure 2. Spectra showing increased peak formation under high ATR crystal pressure